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International variation in invasive care of the elderly with acute coronary syndromes

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Aims To explore variations in invasive care of the elderly with acute coronary syndromes across international practice.
Methods and results Using combined populations from the SYMPHONY and 2nd SYMPHONY trials, we describe 30-day cardiac catheterization in elderly ($\geq$75 years; $n = 1794$) vs. younger patients ($<$75 years; $n = 14\,043$) after multivariable adjustment and by region of enrolment. The use of cardiac catheterization and revascularization were not protocol-specified. Elderly patients (median age 78 years) were more often female and more frequently had hypertension, diabetes, prior myocardial infarction, and prior coronary bypass surgery. Overall, they underwent less cardiac catheterization than younger patients [53 vs. 63%; adjusted OR 0.53 (0.46, 0.60)]. The absolute rate of cardiac catheterization in the elderly varied from 77% (vs. 91% in younger patients) in the US cohort to 27% (vs. 41% in younger patients) in the non-US cohort. Revascularization of elderly who underwent cardiac catheterization was also higher in US than non-US cohorts (71.3 vs. 53.6%). There was a significant interaction between the patient age and the use of catheterization across US and non-US regions of enrolment, as well as differences in the predictors of catheterization in the elderly. Despite these findings, after adjustment, 90-day rates of death and death or myocardial infarction (MI) were not significantly different in elderly who underwent catheterization compared with those who did not.
Conclusion Although older age is universally predictive of lower use of cardiac catheterization, marked variation in catheterization of the elderly exists across international practice. Demonstrated differences in patterns of use suggest a lack of consensus regarding optimal use of an invasive strategy in the elderly.

Introduction

In the setting of uncertainty regarding risk and benefit, invasive care in elderly cardiac patients may be subject to cultural differences in health care values, practice patterns, or resources. Such international differences in health care culture, practice, and economics have been well described.[1–3] These forces may be particularly influential when decision-making is complex and the evidence is limited. The use of cardiac catheterization in the elderly with acute coronary syndromes (ACS) is such an area where limited evidence and patient complexity allow for practice to evolve in disparate ways. Furthermore, the decision to proceed with cardiac catheterization in elderly ACS patients is a simultaneous reflection of their eligibility for revascularization if significant blockages are found. Thus, the rates of invasive care reflect assessments of eligibility for both catheterization and revascularization. The decision for invasive care also encompasses considerations of resources, patient preferences, and provider judgments. In the US, elderly patients with ACS undergo less invasive care relative to younger patients despite its important role in risk stratification following NSTE ACS.[4] The largest remaining gap in ACS care between the old and young is in the use of an invasive strategy. To our knowledge, there has not been another comparison of the influence of patient age on the use of invasive care across international practice. Therefore, we determined if invasive care in the elderly is similarly low or varies in

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important ways across international practice. Our primary goal was to describe patterns of invasive care as a function of age, and to identify predictors of catheterization in the elderly. Using the databases from two large international clinical trials, Sibrafiban vs. aspirin to Yield Maximum Protection from ischaemic Heart events post-acute cOroNary sYndromes trials (SYMPHONY) and 2nd SYMPHONY, we compared the use of cardiac catheterization and subsequent revascularization in elderly patients 30 days following their ACS in US and non-US regions.

Methods

Patient population

The SYMPHONY trials enrolled patients with ACS from August 1997 to August 1999 in 931 clinical centers in 37 countries across five continents. The methods and results of the SYMPHONY and 2nd SYMPHONY trials have been previously published.[5–7] Briefly, SYMPHONY randomized 9233 patients with ACS to aspirin or sibrafiban in one of the two doses (high or low) without concomitant aspirin.[5,6] The 2nd SYMPHONY trial randomized 6671 patients to high-dose sibrafiban, low-dose sibrafiban plus aspirin, or aspirin.[7] Enrolment criteria were the same for both trials and included chest pain or anginal-equivalent symptoms lasting for $\geq$20 min and either positive cardiac markers or electrocardiographic changes consistent with ischaemia. Patients enrolled in these studies had their qualifying ACS event (ST-segment elevation or non-ST-segment elevation MI or unstable angina) within 7 days prior to enrolment and were clinically stable for $\geq$12 h. Exclusion criteria for both trials included serious illness, major surgery, predisposition to bleeding, prior stroke or intracranial haemorrhage, and serum creatinine $>$1.5 mg/dL. The primary endpoint in SYMPHONY was the 90-day composite of death, (re)MI, or severe recurrent ischaemia leading to unplanned revascularization. The time to this composite was the primary endpoint in 2nd SYMPHONY, in which the median treatment duration was 90 (35, 138) days. The SYMPHONY and 2nd SYMPHONY trials were approved by local Ethics Committees and institutional review boards and all patients gave written informed consent to participate.

Study design

The current study is a retrospective observational analysis from the combined databases of the two SYMPHONY trials. After excluding 67 patients without a recorded age, the final analysis population was 15 837 subjects. All outcomes were compared across the age groups, with elderly defined as age $\geq$75 years. The primary outcome of interest was the use of cardiac catheterization 30 days from the initial presentation with an ACS. Secondary analyses included referral for percutaneous coronary intervention (PCI) or coronary bypass surgery (CABG) among those undergoing cardiac catheterization. Death and death or MI at 90 days are shown unadjusted and adjusted for variables in the previously published SYMPHONY models,[8] which include the region of enrolment.

Regional comparisons

The 37 countries participating in SYMPHONY and 2nd SYMPHONY were grouped into seven regions (*Table 1*).[3] Because of the established differences in treatment patterns between the US and Canada, and the much larger enrolment in the US, Canada was included with the non-US practice.[9]

Statistical analysis

Baseline characteristics and use of procedures are shown overall for age $<$75 and $\geq$75 years, and again for age $\geq$75 years among the US and the non-US practices. Descriptive statistics summarizing baseline demographic and clinical characteristics are presented as percentages for discrete variables, and medians (25th and 75th percentiles) for continuous variables. In addition, death for age $<$75 and $\geq$75 years, and for elderly undergoing catheterization in comparison with those not undergoing catheterization are described.

Using multivariable logistic regression, a model was created from the entire population identifying baseline characteristics associated with the use of cardiac catheterization within 30 days (catheterization adjustment model). A second model was developed exclusively in the elderly population (age $\geq$75) to predict the use of cardiac catheterization among patients older than 75 years. An unbiased approach to variable selection was used such that all characteristics available from the case report form were considered initially and refined using clinical input from the investigators.

Variables considered in the modelling for factors associated with the use of catheterization included region, baseline demographic and clinical characteristics (age, race, sex, weight, height, body mass index), past medical history and risk factors (prior PCI, CABG or cardiac catheterization; prior MI, angina, heart failure; diabetes, hypertension, hypercholesterolaemia, smoking status, family history of coronary artery disease, atrial fibrillation, and cancer), qualifying ACS event details [type of qualifying event (QE) (MI or unstable angina), electrocardiographic changes (left bundle

Table 1 Enrolment by region

Region	Countries in region	Regional enrolment (*n*, % of trial total)	Regional elderly enrolment (*n*, % age $\geq$ 75 of region total)
North America	United States	7165 (45.2)	920 (12.8)
	Canada	867 (5.5)	106 (12.2)
Australia/New Zealand	Australia, New Zealand	647 (4)	73 (11.3)
Western Europe	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, The Netherlands, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, United Kingdom	3409 (22)	392 (11.5)
Latin America	Argentina, Brazil, Chile, Mexico	557 (4)	54 (9.7)
Eastern Europe	Bulgaria, Czech Republic, Hungary, Poland, Romania	2647 (17)	202 (7.6)
Asia	China, Hong Kong, Singapore, Taiwan, Thailand	545 (4)	47 (8.6)

branch block, pseudonormalization, ST-segment depression, T-wave inversion, ST-segment elevation), cardiac marker status, heart rate, blood pressure, serum creatinine, creatinine clearance, Killip class, mitral regurgitation, pulmonary oedema], and clinical details and events occurring from the QE to enrolment [time to treatment from QE and occurrence of atrioventricular block, ventricular fibrillation, recurrent ischaemia, and congestive heart failure (CHF)]. Significant variables ($P < 0.05$) were retained and interaction terms between region and key variables as well as a variable for non-US enrolment were tested. The linearity of continuous variables in the models was tested using restricted cubic splines. Significant variables in the overall catheterization model included age, weight, race, angina in prior 6 weeks, CHF, prior PCI, prior angina, smoking, insulin use, and QE variables of HR, CHF, Q-waves on EKG, and recurrent ischaemia. Significant variables in the elderly catheterization model are shown in *Table 2*.

The adjusted association of cardiac catheterization with 90-day mortality in the elderly was determined using the previously developed 90-day SYMPHONY mortality model, adjusting also for the propensity score for use of catheterization as a continuous variable in the outcome model. Because cardiac catheterization was a post-randomization factor in an observational analysis, we display results, but caution against over-interpretation of these adjusted analyses. The 90-day mortality modelling methods and the final model have been previously published;[8] the final mortality model included age, QE CHF, randomization heart rate, prior CHF, pre-randomization PCI, ACE-inhibitor use, creatinine clearance, prior TIA, streptokinase use, QE MI, prior MI, Latin America, control arm, prior chronic obstructive pulmonary disease, angina within prior 6 weeks, hypertension, and prior angiography.

All statistical analyses were performed using SAS version 8.2 statistical software (SAS Institute, Cary, NC, USA).

Results

Patient population

Among the 15 837 patients in our analysis, more than half ($n = 8672$) were enrolled in the six non-US regions (55% non-US vs. 45% US). The majority of non-US patients were enrolled in Western Europe (22%), followed by Eastern Europe (17%), Canada (5%), and 4% each from Latin America, Australia, New Zealand, and Asia (*Table 1*). Overall, 11.3% ($n = 1794$) of the enrolled population were elderly (≥75 years old). The proportion of the elderly varied slightly by region, and was highest in the US, Canada, and Western Europe (range: 8–13%) (*Table 1*).

Compared with patients <75 years, elderly patients were more often female, with lower body weight and creatinine clearance, and had more hypertension, diabetes, prior cardiac diagnoses than younger patients. They were less likely to be current smokers (*Table 3*). The elderly presented with higher Killip class, more CHF, and QE, which were more often unstable angina (vs. MI in younger patients).

Baseline characteristics in the elderly population (age ≥75 years) varied slightly by region (*Table 3*). The non-US elderly were younger (77 vs. 78 years), weighed less (71 vs. 73 kg), and had less diabetes (19.8 vs. 21.7%) and hypertension (51.4 vs. 63.8%) than the US elderly. Conversely, they had higher rates of current smoking (11 vs. 8%) and angina in the prior 6 weeks (48.4 vs. 40.4%). The US elderly more often had a history of cardiac procedures prior to enrolment than the non-US elderly.

Table 2 Multivariable predictors of cardiac catheterization at 30 days post-ACS in the elderly

Variable	OR
US enrolment[a]	8.35 (5.09, 13.69)
Eastern Europe[a]	0.08 (0.04, 0.16)
Age per 1 year[b]	0.85 (0.82, 0.88)
QE Killip > 1	0.60 (0.43, 0.83)
Prior CHF (non-US enrolment)	1.48 (0.77, 2.86)
Prior CHF (US enrolment)	0.37 (0.23, 0.59)
Prior PCI (non-US enrolment)	4.68 (2.27, 9.64)
Prior PCI (US enrolment)	1.22 (0.75, 1.97)
QE MI (non-US enrolment)	0.58 (0.40, 0.83)
QE MI (US enrolment)	1.06 (0.70, 1.58)
Angina within 6 weeks prior to QE	1.30 (1.00, 1.67)
QE heart rate ≤60 bpm	1.04 (0.99, 1.09)
QE heart rate >60 bpm	0.99 (0.98, 0.99)
Weight ≤55 kg	1.15 (1.07, 1.24)
Weight >55 kg	1.00 (0.99, 1.01)
Control arm	1.43 (1.10, 1.85)

[a]Reference group for US and Eastern Europe is Western Europe, Canada, Australia/New Zealand, Latin America, and Asia.

[b]Age per 1 year with significant age by region interaction (*Figure 1*), heart rate per 1 bpm increase, weight per 1 kg increase.

Predictors of cardiac catheterization in the elderly

Variables that were associated with the use of invasive care among the elderly (age ≥75) are shown in *Table 2*. Among patients ≥75 years, each year of advancing age was associated with a 15% lower likelihood of cardiac catheterization [OR per 1 year = 0.85 (0.82, 0.88)]. Elderly patients were less likely to undergo cardiac catheterization if they had QE Killip class >1, or heart rate >60 bpm, and were more likely to undergo catheterization if they had angina in the previous six weeks. In the non-US regions, prior MI was associated with a lower likelihood of catheterization, whereas prior CHF or prior PCI was associated with a greater likelihood. The relationships were opposite within US care, with prior CHF associated with a lower, and prior MI and prior PCI tending to a higher likelihood of catheterization. Enrolment in all non-US regions was associated with a lower likelihood of invasive care in the elderly in comparison with enrolment in the US.

Cardiac catheterization by region and age

The highest rate of cardiac catheterization in the elderly occurred in the US (77 vs. 27% non-US). The non-US catheterization rates ranged from a high of 53% in Asia to a low of 5% in Eastern Europe. The rate of cardiac catheterization among patients <75 years was 91% in the US compared with 41% in the non-US practice (*Table 4*). Rates of cardiac catheterization among younger patients were higher than among the elderly in all regions, but the relative differences in use by age group varied by region.

After accounting for factors that are associated with the undergoing cardiac catheterization, elderly patients (age ≥75) were half as likely as younger patients to undergo cardiac catheterization [OR 0.53 (0.46, 0.60)] (*Table 4*). In general, this pattern held across all regions, with the exception of Asia where no age difference in the use of cardiac catheterization was observed after adjustment [OR 1.19 (0.58, 2.09)]. The difference in use by age was greatest in

Table 3 Baseline characteristics by age and region of enrolment

	Overall (age <75, $n = 14\,043$)	Overall (age ≥ 75, $n = 1794$)	United States (age ≥ 75, $n = 920$)	Non-United States (age ≥ 75, $n = 874$)
Demographics and history				
Age (years)[a]	58 (50, 65)	78 (76, 81)	78 (76, 82)	77 (76, 80)
Weight (kg)[a]	82 (72, 93)	72 (63, 81)	73 (64, 82)	71 (63, 80)
Female	25.0 (3492)	47.0 (843)	49.0 (449)	45.0 (394)
Non-white	13.0 (1847)	9.7 (173)	9.0 (87)	10.0 (86)
Current smoker	41.0 (5694)	9.0 (169)	8.0 (73)	11.0 (96)
Past smoker	32.0 (4424)	39.0 (699)	44.0 (402)	34.0 (297)
History of CHF	3.6 (510)	9.8 (175)	11.9 (109)	7.6 (66)
Hypertension	48.5 (6803)	57.8 (1035)	63.8 (586)	51.4 (449)
Diabetes	17.8 (2496)	20.8 (373)	21.7 (200)	19.8 (173)
Angina in prior 6 weeks	43.9 (6158)	44.5 (798)	40.8 (375)	48.4 (423)
Prior MI	19.3 (2707)	26.8 (480)	28.4 (261)	25.1 (219)
Prior PCI	10.7 (1502)	11.3 (203)	17.4 (159)	5.0 (44)
Prior coronary bypass surgery	8.5 (1174)	13.4 (236)	20.4 (186)	5.8 (50)
Prior atrial fibrillation	3.1 (437)	9.4 (169)	10.5 (97)	8.2 (72)
Creatinine clearance (mL/min/1.73 m^2)[a]	91 (73, 113)	55 (45, 66)	56 (46, 68)	53 (45, 64)
QE details				
QE MI	73.6 (10376)	69.3 (1250)	73.9 (679)	65.4 (571)
ST elevation on QE electrocardiogram	55.5 (7700)	44.2 (782)	38.5 (349)	50.1 (433)
QE heart rate (per 5 bpm)[a]	76 (65, 88)	75 (65, 88)	76 (65, 88)	75 (65, 88)
QE systolic blood pressure (mmHg)[a]	140 (123, 160)	145 (129, 167)	146 (128, 167)	145 (130, 165)
Elevated cardiac markers at QE	82.7 (11 321)	80.3 (1405)	84.3 (756)	76.2 (649)
QE Killip class ≥ II	10.0 (1382)	17.5 (310)	15.9 (145)	19.1 (165)
Recurrent ischaemia from QE to enrolment	7.7 (1087)	8.1 (145)	7.3 (67)	9.0 (78)

All values are percentages and (frequencies).
[a]Medians (25th, 75th percentiles).

Table 4 Cardiac catheterization 30 days post-ACS in elderly compared with younger patients

Region	Age <75% ($n = 14\,043$)	Age ≥75% ($n = 1794$)	Adjusted OR (95% confidence interval)
Overall	63 (8814)	53 (944)	0.53 (0.46, 0.60)
US	91 (5658)	77 (705)	0.40 (0.33, 0.50)
Non-US	41 (3156)	27 (239)	0.61 (0.52, 0.73)
Asia	56 (279)	53 (25)	1.10 (0.58, 2.09)
Latin America	53 (268)	41 (22)	0.53 (0.28, 1.03)
Western Europe	54 (1620)	33 (131)	0.44 (0.34, 0.56)
Canada	42 (318)	29 (31)	0.50 (0.30, 0.84)
Australia/ New Zealand	51 (292)	26 (73)	0.34 (0.19, 0.63)
Eastern Europe	16 (379)	5 (11)	0.33 (0.17, 0.63)

Shown as % (*n*).

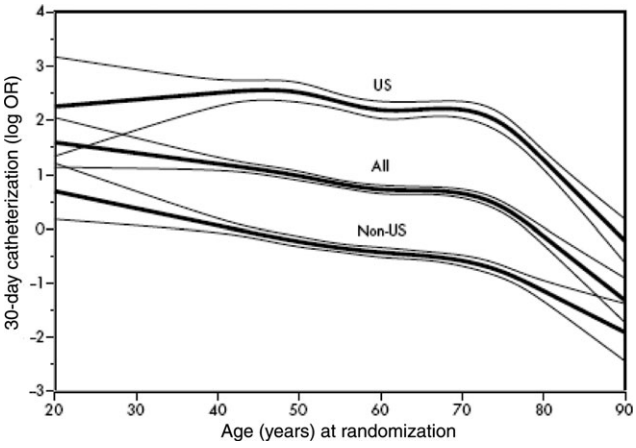

Figure 1 Log OR plot of likelihood of undergoing diagnostic cardiac catheterization during 30 days post-ACS as a function of patient age adjusted for all factors predictive of the use of catheterization. Three lines represent the overall, US, and non-US relationship between catheterization and age.

Eastern Europe [OR 0.33 (0.17, 0.63)]. The continuous relationship between advancing age and the use of catheterization varied significantly across the US and non-US regions as displayed in *Figure 1*. A decline in catheterization in both US and non-US regions was observed as age increased, and was most noted after 75 years of age. However, there was a significant age-by-region interaction (US region *age, $P = 0.006$). This was due to the higher rate of catheterization in younger patients in US practice that was followed by a rapid decline in older patients compared with the more gradual decline with age in non-US practice.

Of note, the majority of cardiac catheterizations performed within the first 30 days were performed within the first 2 days following QE (55%). Early catheterization was more common in the US practice than in the non-US practice (70 vs. 27%). In addition, early catheterization was more common among younger patients than older patients in the US (71 vs. 59%), but not in the non-US practice (27 vs. 25%).

Table 5 Regional use of cardiac testing and revascularization at 30 days post-ACS in the elderly

Elderly by region (*n*)	Stress testing	Echo	Cardiac catheterization	Any cardiac testing[a]	Revascularization[b] Overall [PCI, CABG]
All patients (1794)	14 (247)	19 (349)	53 (944)	69 (1234)	67 (631) [54, 14]
US (920)	11 (101)	11 (103)	77 (705)	81 (747)	71 (503) [58, 13]
Non-US (874)	17 (146)	28 (246)	27 (239)	56 (487)	54 (128) [39, 15]
Asia (47)	2 (1)	17 (8)	53 (25)	62 (29)	44 (11) [40, 4]
Latin America (54)	7 (4)	19 (10)	41 (22)	52 (28)	45 (10) [18, 27]
Western Europe (392)	23 (90)	25 (96)	33 (131)	57 (225)	58 (76) [44, 15]
Canada (106)	22 (23)	22 (23)	29 (31)	58 (61)	58 (18) [48, 13]
Australia/New Zealand (73)	23 (17)	23 (17)	26 (19)	62 (45)	47 (9) [26, 21]
Eastern Europe (202)	5 (11)	46 (92)	5 (11)	49 (99)	36 (4) [18,18]

[a]Either coronary angiography or echocardiography or stress testing. Shown as % (*n*).
[b]PCI or coronary bypass surgery among population who underwent coronary angiography. Shown as % (*n*) [%PCI, %CABG].

Diagnostic testing and revascularization

Cardiac catheterization was the most commonly used diagnostic test in all regions (*Table 5*). The invasive approach in the US practice extended to the use of revascularization among elderly who undergo catheterization (71% of elderly patient undergoing cardiac catheterization being revascularized in the US vs. 54% in the non-US cohort). Use of alternative risk stratification with stress testing and echocardiography was low across all regions, but more common in the non-US cohort (19.7% US vs. 37.6% non-US). Considering the combined use of invasive or non-invasive testing (excluding echo), the number of elderly tested in Canada, Australia/New Zealand, and Western Europe increased, but there was little increment in testing observed in regions with either high or low rates of invasive care (US, Asia, and Eastern Europe). For example, Eastern Europe had the lowest use of any cardiac testing (10%) and the lowest use of stress testing (5%) (*Table 5*). Overall, 69% of the elderly patients in SYMPHONY underwent some form of cardiac risk assessment (81% US vs. 56% non-US), and about a third of elderly who had a catheterization went on to some form of revascularization (*Table 5*).

Outcomes in the elderly

Elderly patients had worse 90-days outcomes compared with younger patients even after adjusting for baseline differences, region of enrolment, and use of invasive care. Death at 90 days was 1.4% for age $<$75 and 5.3% for age $\geq$75 [adjusted OR 1.8 (1.3, 2.5)]. Among the elderly (age $\geq$75 years), those who underwent catheterization had lower rates of death overall (4.2 vs. 6.5% no catheterization), and in US (3.7 vs. 6.5% no catheterization), and non-US (5.9 vs. 6.5% no catheterization) practices. However, the trends to higher mortality among those not undergoing catheterization were no longer significant after adjustment for predictors of mortality and propensity for cardiac catheterization in the overall population [adjusted OR 1.18 (0.67, 2.07)], or in the US [adjusted OR 1.42 (0.60, 3.38)] or in the non-US regions [adjusted OR 1.11 (0.50, 2.45)].

Discussion

Variations in international practice have indeed been previously described,[1,2,9–11] but have now also been demonstrated to extend to invasive management of the elderly. We found that although the absolute rate of cardiac catheterization in the elderly is markedly higher in a US cohort, regardless of the region, the use of catheterization declined with age. The relative use of catheterization in elderly vs. younger patients varied by region and local care patterns. In regions where invasive care was uncommon, like Eastern Europe, we observed the greatest additional decrement with age. However, even in the US cohort in which the absolute rate was highest, the relative reductions in catheterization past the age of 75 were notable and demonstrate a significant interaction between the age and the procedure used. Thus, while invasive care is more directly influenced by age in high resource use areas like the US, factors like availability and resources may be more influential in non-US regions. Interestingly, in our analysis, Asia was the only region where age was not associated with the use of cardiac catheterization, though this finding was from data in only 47 patients.

Lower availability of catheterization labs and longer waiting times for procedures have been demonstrated in Canada where the wait time between MI and angioplasty was 28 days compared with less than 2 days in the US.[1] These forces are similar in other health care systems as well. Although the invasive care over the last decade has increased in Canada and the US, the US practice remains more invasive in comparison after accounting for differences in wait times, physician speciality, and procedure availability.[12] In health care environments where catheterization is less available, management may focus on risk-stratification testing. However, we found that differences in invasive management were not explained by alternative risk stratification testing between the US and the non-US practices. Although these care patterns raise questions regarding the influence of culture and resources on patient management, one can only speculate regarding their long-term impact.

Comparable or lower rates of death have been reported among post-MI patients in the US compared with non-US regions.[13] In addition, a better quality of life in the year following an MI has also been demonstrated in regions with high rates of invasive management.[10,14] The randomized use of invasive care had recently been evaluated in a large meta-analysis, which demonstrated lower rates of MI, angina, and rehospitalization when early catheterization

was an assigned treatment.[15] However, benefits from invasive care clearly vary based on the population studied, use of revascularization and concomitant therapies, and the duration of follow-up. For example, patients who are managed with a selective invasive approach have also been shown to have similar outcomes at 1 year in a randomized trial.[16] In all these trials, few 'very elderly' were included, and similarly only 12% of the SYMPHONY population was over 75.[17] However, benefits of an invasive strategy for ACS among elderly (age >70) has recently been demonstrated in the TACTICS-TIMI 18 trial, which showed fewer rehospitalizations and less death and MI during short-term follow-up.[18–21] Over time, elderly with chronic angina also achieve benefits from invasive management over optimal medical treatment, with fewer adverse cardiac events and rehospitalizations at 1 year.[22] Our data confirm that the elderly are at high risk, but found no differences in outcomes for elderly patients as a function of invasive management after adjusting for predictors of catheterization and mortality.

We were not able to assess the impact of invasive management on quality of life or symptom status. However, given that selected high-risk elderly do well with an invasive approach, and knowing that recurrent ischaemic events are common, age should not exclude patients from invasive evaluation.[23] The use of invasive care in selected high-risk patients regardless of age is supported by European and American guidelines for unstable angina and non-ST-segment elevation MI.[24,25] Despite their potential for benefit, the elderly remain less likely to undergo cardiac catheterization across international practice, with a particular decline related to age seen within the highly invasive US practice.

Many unresolved issues remain in the care of elderly patients with coronary artery disease. Our data demonstrate that the elderly who are selected for cardiac catheterization included those with recent angina or prior PCI; however, elderly with other high-risk features such as current or prior heart failure were less likely to receive invasive care. In order to provide net benefit, invasive care must be applied with judgment considering comorbidity and special circumstances in the elderly. However, the marked variation in the use of invasive care across international practice suggests a lack of consensus regarding the best approach to these decisions in elderly patients.

Limitations

Patients selected for clinical trial may be different in many ways from patients seen in community practice. In the case of our analysis, it is important to note that the entry criteria for the SYMPHONY trials excluded patients with a serum creatinine >1.5 mg/dL. Because the diminished renal function may reduce the likelihood of a patient undergoing cardiac catheterization due to concerns of nephrotoxicity of contrast administration and as diminished renal function occurs with aging, our results may underestimate disparities in the use of cardiac catheterization between older and younger patients. We cannot determine the causality from our observations. In addition, the use of invasive care may also be determined by unmeasured comorbidities, frailty, or patient preferences. We are unable to account for these confounding variables as these are not currently assessed in clinical trial databases. In addition, due to limited resources, some regions may have more than a 30-day wait for catheterization following an index event; thus, we may underestimate the intended use of cardiac catheterization in those regions.

Conclusions

While management for ACS differs across international practice, the directionality of the association between the patient age and the treatment is shared. Although hypothesis generating, the role of patient age in determining health care appears most evident in environments with either low or high use of invasive resources. Best practice must be regionally defined, but rational care of the elderly should include an awareness of the importance of invasive management in selected patients in reducing events following ACS.

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